THE FUTURE OF THE COUNTY INVERTEBRATE ATLAS

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Abstract. County atlases need to move away from the traditional dot-map approach to one that helps to answer questions and poses new questions to be tackled as part of the development of Biodiversity Action Plans. This is an opportunity for the entomological community and others to demonstrate the contribution that the amateur naturalist has made, and is making, to our knowledge of the British fauna. Projects such as the Surrey Wildlife Atlas series clearly demonstrate that a new approach is possible, but there is also a need for innovative approaches to sponsorship, marketing and fund management. This account discusses some of the lessons learnt during production of one volume for the series and provides guidelines for future recorders.

INTRODUCTION

At the dawn of the 20th Century the *Victoria County Histories* provided the main written record of the fauna of the Counties of Britain. These accounts were based on an imprecise knowledge of the full extent of the British fauna and, as such, many must be treated with a degree of caution. Even so, they remain an important historical record and the foundation for subsequent accounts. Since then, biological recording has been transformed. The national mapping schemes organised through the Biological Records Centre at Monks Wood are best known, but can only produce an outline of overall national distribution. The production of county accounts by local enthusiasts, even simple lists that outline the general extent of individual species' distributions (e.g. Chandler, 1969), were an important advance, but county atlases provide a much more detailed picture of plant and animal distribution at a local level.

Early mapping schemes largely comprised the collection of data sufficient to produce dot maps, but often failed to capture a great deal of incidental information which makes a recording scheme really worth supporting. Such data remain in the national datasets and are a disappointment because so much more could be done with them today if only they were more detailed. At a local level, publications might also have included accounts of noteworthy species from particular sites, or records of rarer species, but in today's world such accounts are of limited value unless some interpretation is attached and data are provided to properly identify the locations of their occurrence.

Amongst the models available in the mid-1980s when the Surrey Atlas recorders started work were Emmet & Pyman (1985) and Evans & Evans (1973) for moths; Rotheray (1979) for hoverflies; and Burton (1983), Lousley (1976) and Philp (1982) for vascular plants. At that time, the botanists, especially Lousley, were the only ones to make a serious attempt to consider biogeography in any detail. Even today, new works place very little emphasis on interpreting invertebrate distribution in relation to drift and hard geology, yet this concept is well known and has been adopted for some time by English Nature as a foundation for local conservation strategies (the concept of "Natural Areas"). The importance of these physical attributes for invertebrate distribution cannot be over-emphasised. For example, the solid geology

will affect the nature of groundwater emerging from flushes, and depending upon the level of base-richness, this will affect the distribution of assemblages such as soldier-flies. Equally, the general porosity of surface layers will also affect the distribution of other species such as those associated with thermophilic conditions and good drainage; thus there is coincidence between such species and drift deposits such as the periglacial sands of Lincolnshire and East Anglia.

The Potential Worth of the County Atlas

Any atlas is a snapshot in time, reflecting what the enthusiasts consider important at that moment. But, today's atlas will have a far wider audience. This is particularly true in terms of nature conservation where land-use planning requires environmental assessment, and major conservation initiatives are directed through the Biodiversity planning process (DoE, 1994; DoE, 1995). Both draw on the published understanding of localised distribution of plants and animals, but it is the latter which could be an important driver and opportunity for the entomological community.

Depending on the available literature and previous interest in a particular group, the historical record is the foundation for any new atlas. What have been the additions, changes and losses over recorded time? Published records for a particular area are, however, highly dependent on a sequence of field naturalists with relevant interests working the same area over a long timescale. The bulk of the atlas will, however, concentrate on the known current distribution of individual species. Given sufficiently detailed recording, they are the foundation upon which Biodiversity Action Plans may be formulated in a county context. With few exceptions, however, it is unlikely that the current generation of maps will properly reflect many major declines or expansions, because of the inconsistencies and disparities between past and present recording effort. Moreover, real changes can only be properly identified by standardised recording methods, which are largely outside the scope of county schemes.

Even so, expansions and contractions of range can be discerned and are sometimes well publicised, e.g. the demise of the large blue *Maculinea arion* (L.) and the expansions of range of Roesel's bush-cricket *Metrioptera roeselii* (Hagenbach), the long-winged cone-head *Conocephalus discolor* (Thunberg), and the bee-wolf *Philanthus triangulum* (Fabricius). All of these have been quite dramatic and are therefore well known, but slower declines or expansions are harder to pick up with poor historic coverage and inconsistent levels of recording. Thus, today's atlases, which should be the foundation for establishing trends in distribution and frequency, must be based on comprehensive, detailed and accurate records which are accessible in the future.

In recent years, county atlases have been an important vehicle for developing ideas on invertebrate indicators and assemblages. Starting with dead-wood hoverfly assemblages first proposed by Stubbs (1982), Whiteley (1987) refined the concept and added a series of possible wetland hoverfly indicators, to which there are now ideas on heathland and chalk downland hoverfly assemblages (Morris, 1998). All of these indicator lists have largely arisen from the county atlas process, and scope for developing indicator assemblages improves with greater knowledge of a particular biogeographic zone. For example, in Surrey, an extensive range of possible heathland and chalk grassland/woodland indicators could be proposed, drawing on detailed maps for butterflies (Collins, 1995), dragonflies (Follett, 1996), larger moths (Collins, 1997), hoverflies (Morris, 1998) grasshoppers and crickets (Baldock, 1999), ladybirds (Hawkins, 2000).

Habitat indicators can be helpful in conservation management, and interpretation of datasets supplied for sites. They are particularly useful for the non-specialists who

would not otherwise know the range of species with particular habitat affinities but may need to as part of their job (e.g. Conservation Officers in English Nature or the Wildlife Trusts). For example, the presence of species with particular habitat affinities included on lists for sites that do not support such habitats may raise doubts about the records themselves or may suggest that records represent vagrants. Equally, the absence of specialist species from lists may give an indication of the impacts of particular management regimes or the degree of recording effort. Whichever is the case, such records require further investigation.

The Surrey Wildlife Atlas series has shown that county atlases can also be used for disseminating new biological information, including those odd anecdotal comments that might be lost in a notebook or obscurely noted in a journal. For the entomologist it is an excellent opportunity to provide new information on food plants, flower visits, prey items or behavioural observations. With sufficient data, local phenology can be depicted. Similarly, investigations into changing frequency or responses to climate could lead to a more rounded and comprehensive publication. If, however, the principal recorder is not greatly motivated by such fields, the data are centralised and might be forwarded to others for more detailed investigation. The key message is that the establishment of a recording scheme is an opportunity to create a data set which may be of use not only now, but also across a range of applications in future, both nationally and by local records centres.

The production of an atlas has the potential to be an important driver for renewed recording activity. It can either stimulate individuals to visit sites which they have not visited previously or may encourage them to forward the data they hold in notebooks or in machine-readable form. Both of these impacts are important, firstly in widening the available coverage; secondly by capturing a body of information that was hitherto largely inaccessible. Ideally it should also lead to improved recording quality as well as ensuring that relevant data are incorporated into the data set.

Links to Biodiversity Planning

A great deal of effort and money is going into the production of national, regional and local Biodiversity Action Plans. Partnerships led by statutory conservation agencies (Countryside Council for Wales, English Nature and Scottish Natural Heritage) the national voluntary organisations (e.g. RSPB and the Wildlife Trusts) and local authorities (County, Metropolitan, Unitary or District Councils) have been established. Key to the delivery of Biodiversity plans is the survey and monitoring package that evaluates needs and successes; this is the National Biodiversity Network (NBN). RECORDER 2000 is intended to provide the means of capturing the data and provides the links between local records centres and national initiatives to monitor the status of British wildlife.

Usually, the first point of action for lesser-known taxa is a new survey. This is a major opportunity for local recording schemes to work in partnership, where recorders provide the data and, *hopefully*, the Biodiversity partnership provides the resources to disseminate the results; but it must be a symbiotic relationship. Recorders must recognise that the data collected has more of a purpose than simply producing a dot map or guide to the best places to record/collect insects; and the Biodiversity partnerships must not simply see the recorders as providers of information on the cheap.

Entomologists are encouraged to supply data not only to recording schemes, but also to site owners and managers. A simple list of species recorded is often the best that a site manager can expect, so the publication of a county atlas that helps to put

the records into context is of particular value. This should augment the advice and information provided in the various national reviews (e.g. Falk, 1991; Kirby, 1992; Hyman & Parsons, 1992). A further improvement to an atlas would be the inclusion of notes on specific conservation measures which may be helpful in a county context, spelling out the importance of particular habitats or features which are overlooked, scarce or under-valued.

A well produced and researched county atlas may also act as the vehicle for disseminating the actions needed to secure the well-being of locally or nationally threatened species. Follow-on projects could be initiated in a similar way to the work of the BENHS on the hoverfly *Chrysotoxum octomaculatum* Curtis, the robberfly *Asilus crabroniformis* Linnaeus and the bee-fly *Thyridanthrax fenestratus* (Fallén) (Miles, 1999).

Population Trend Analysis

Analysis of the data collected for Surrey from 1985 to date provides a number of indications of population and phenological trends. For example, the apparent declines in frequency of the hoverflies *Rhingia campestris* Meigen and *Platycheirus peltatus* (Meigen) are discussed in Morris (1998). The analysis of *Rhingia campestris* stimulated further countrywide analysis leading to a much better understanding of the relationship between the frequency of this species and periods of drought (Ball & Morris *in prep.*). Changes in the emergence times of *Epistrophe eligans* (Harris) are also apparent over the same period (Morris, 2000), showing that this species has undergone a clear shift towards earlier emergence. Extensive recording has also provided an opportunity to evaluate the real or perceived scarcity of particular species. A good example of this is that of the bee *Hylaeus cornutus* Curtis which is listed as Red Data Book 3 in Falk (1991), but is actually widely distributed across ruderal sites in the London suburbs (Morris, 1992).

These examples illustrate how important it is for recorders to get away from the concept of only visiting 'good' sites, retaining records of just the spectacular or scarce species, or simply noting first and last dates of occurrence. There are a number of key messages which all entomologists would be advised to take on board:

- Make an effort to record from sites that do not immediately strike you as exceptional.
- Retain data on all species encountered, not just the rarities.
- Try to retain material from other taxa which can be forwarded for identification by others.
- If you run static traps (such as malaise traps) try to get as much material as possible identified by offering material to recorders of taxa other than those in which you are interested.
- Try to retain quantitative as well as qualitative data.
- Encourage friends to take a similarly enlightened approach.

Data Requirements and Lessons

Ball and Morris (1992) provided clear instructions to recorders of the national Hoverfly Recording Scheme, which might usefully be repeated here:

1. All records should comprise a full date, the site name and name of the recorder. Recorders should not give a date range (e.g. 1978–1995), as this is not even helpful in producing a dot map across date classes.

2. A four-figure grid reference is the minimum required; six-figure references are more desirable but only if they can be accurately ascribed to the location of capture.
3. Where possible, records should be accompanied by notes on flower visits, oviposition behaviour or prey items.
4. Details of the habitat should be provided, but generalised notes such as 'hedgerows, grassland, woodland and scrub' are fairly meaningless. A more detailed description of the site as a whole would be helpful, and in particular a description of the site of capture.
5. Details of site ownership should be given if known.
6. The altitude of the capture site (in metres or feet) is helpful.
7. If records are passed on third-hand, they can often lead to confusion unless they are conveyed accurately.

As a minimum, the first two criteria are essential.

Most recording schemes have a tendency for the maps to reflect recorder effort and not the true distribution of species (Rich, 1998). To overcome this, the Surrey Wildlife Atlas Project recorders have made strenuous efforts to visit as many otherwise unrecorded sites (tetrads) as possible. As a result, 95% of the 540 tetrads in Surrey were visited during the hoverfly survey for example; this included many sites that would have failed to inspire the majority of entomologists and which frequently yielded few noteworthy records.

Ideally, data should be collected in an entirely consistent manner, ensuring that coverage is even both in terms of recording intensity on a particular visit and in terms of the numbers and spacing of visits over a season, as described by Rich (1998). There is, however, a long way to go before there are sufficient recorders who are both taxonomically competent and committed to data collection. Furthermore, recording invertebrates is largely dictated by favourable weather, so employing the rigorous survey that botanists can adopt is simply not feasible. At this stage the key lessons are:

- Encourage recorders to visit as wide a range of sites as possible.
- Encourage repeat visits over the entire season.
- Encourage collection of material for schemes in addition to your own.
- Push for as much detail as possible.
- Provide feedback on gaps in the data.
- Be prepared to discount data that are incomplete or seemingly inaccurate.

Even with a very active recording scheme organiser, the vast bulk of records are likely to come from a nucleus of perhaps a dozen individuals, with small-scale contributions from many others. To be a success, a scheme needs to show that it is making progress and is giving feedback. Production of a newsletter is one obvious way of giving feedback, but other ways include making an effort to contribute to other schemes; such data are appreciated and may lead to better links between recorders. Importantly, making an effort to collect a wider range of data than just one's own interest area means that the returns from time and financial costs of survey are maximised. Also, it is quite surprising just how often one gets a disproportionately large number of records of scarce species when collecting groups other than one's own specialism.

Database Management

There are a number of good databases on the market (e.g. MAPMATE), but the most versatile is RECORDER 2000, marketed by the UK Joint Nature Conservation Committee. Despite this versatility, it is not regarded as a straightforward package and has attracted disparaging comments to the extent that the majority of recorders prefer other packages. Ideally, before starting to enter data, establish whether the local records centre (often run by the County Wildlife Trust) has a standard list of sites and boundary maps. Synergy with others will ultimately mean that data can be more readily incorporated into a database, which is used to safeguard sites and inform the Biodiversity process. Some centres may even establish close links with you so that you get help with setting up your database.

The maps produced for this article and for the Surrey atlases were all produced using the UK DMAP package (in its Windows version). This is a very simple package, but there may be a need to create new boundary files unless they can be obtained from other sources. For further information on this program and its implementation, see Morton and Collins (1992).

Atlas Production

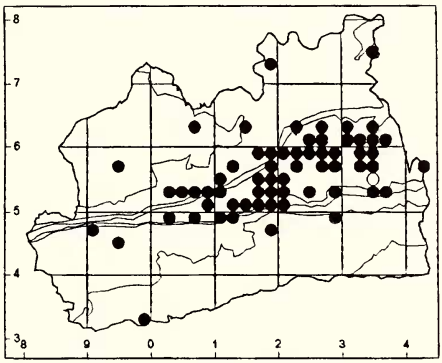
Planning the project is always very difficult without an idea of the likely format and the funds that might be available for inclusion of illustrations and photographs. Even so, it is worth starting the writing process early on. This allows time for the development of ideas, which can be tested as the project develops; for example testing the validity of possible indicator assemblages or impressions gained of the ecology of particular species. Literature searches often yield interesting anecdotes, which lighten the text and may also provide avenues for investigation if undertaken at an early stage. Likewise, it is important to plan for photographic illustrations and to make sure that they will be available.

If a county atlas is to be of any real use today, bearing in mind the need to establish links with geology and known distribution of habitats, it is essential to chose a scale for mapping that can be used to interpret patterns of distribution. To emphasise this, Fig. 1 depicts the distribution of the hoverfly *Cheilosia soror* (Zetterstedt), a known indicator of calcareous habitats. Even the shift from tetrad (2-km square) to 5-km squares masks the distribution considerably, whilst that for 10-km squares is next to useless. This is an important lesson to remember and emphasises just how important it is to get as detailed and widespread coverage as possible. It is also important to remember that mapping packages can translate more accurate grid references into the cruder grids used for mapping, but cannot do this in reverse if the data are not that accurate in the first place; thus all data should be stored in their most accurate form.

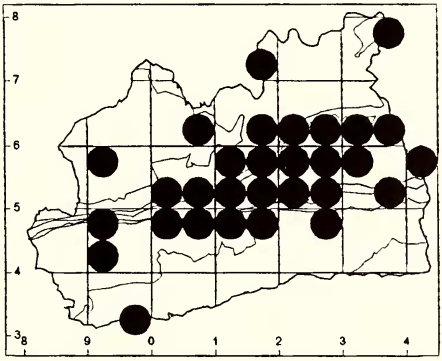
Marketing and Sponsorship Strategies

The Surrey Wildlife Atlas Project provides a useful model of how a series of publications can be achieved using pump-priming. The Project is a partnership between local recorders and the Surrey Wildlife Trust, with the recorders undertaking the fieldwork and preparing the texts, and the Trust undertaking the

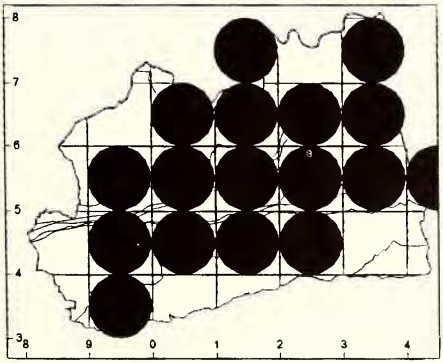
The distribution of *Cheilosia soror* in Surrey



Distribution at tetrad level (2km^2)



Distribution at 5km^2 level



Distribution at 10km^2 level

Fig. 1. The distribution of *Cheilosia soror* at 2 km, 5 km and 10 km.

typesetting, print management and marketing. Production of the early volumes was also greatly helped by the Trust making no charge to the production account for typesetting costs which were done 'in house', although this is of course an option that is not always available to other projects.

The project started with popular volumes (Butterflies and Dragonflies) that would attract sponsorship and would sell well, which meant that a reserve of income was quickly generated and could be used to offset the costs of later publications. Running at one volume per year, this has been possible for the first seven years, but as less popular groups are covered there has been a need to seek further priming sponsorship. Even so, for a relatively modest level of sponsorship (ca. £22,000), a widely applauded series (7 volumes) has been produced and has established the foundation for many future titles. The important lesson is the value of creating a loop whereby income from sales underpins the next volume, a model that could be adopted by Biodiversity partnerships across the country.

The Surrey Wildlife Atlas project opted to produce volumes that were both informative and attractive. Colour plates are incorporated at considerable cost, but these make the series appealing to a much wider audience and perhaps also make them more marketable to those with just a passing interest in, say, hoverflies or larger moths. Some reviews have questioned the scientific worth of such illustrations (e.g. Agassiz, 1998), but in marketing terms they are invaluable. Indeed, such an approach can greatly enhance the reputation of a series e.g. Marren (2002) who compares favourably the extent of colour plates in *Reptiles and Amphibians of Surrey* (Wycherley & Anstis, 2001) with those of the comparable New Naturalist. This may not offer the scientific purist any comfort, but it is important to remember that sales to a wider audience mean that income is maximised early on and books do not end up stockpiled (they can take up a great deal of space and are not earning anything).

Recouping costs quickly is an important factor in allowing the establishment of an ongoing series; in my view, a title going out of print relatively quickly (given a reasonable print run) is a good thing because it has proved popular and generates income for future titles. Thus, pricing is a fine balance between achieving sufficient return on the investment to fund future volumes and setting a price that attracts readers who might not otherwise make such a purchase. The Surrey Wildlife Atlases are noted for their reasonable price: for example Marren (2002) remarks on this achievement when comparing the recently published Amphibians and Reptiles volume with the comparable New Naturalist. However, trade sales of the Atlas series, which comprise a not insignificant proportion of the sales, do little more than recoup costs on unit price.

Deciding on the length of the print run is very important. A short print run puts up the unit price, whilst longer runs reduce the unit price and increase storage costs. Before deciding on a print run, consider seeking advice from others who have published similar works and get an idea of what the market will support. Figure 2 provides some feedback on the relative marketability of the Surrey Wildlife Atlas series. Likewise, it is worth weighing up the merits of softback and hardback; the unit cost of hardback is not that high, but can substantially improve a book's marketability. Similarly, the format is important. Remember that bigger formats demand greater shelf space and balance this against the benefits or disadvantages that such a format gives in terms of layout. The Surrey Wildlife Atlas series is A5, a format which seems to work very well. The main issue to consider is how to get back the original investment sufficiently quickly that it can be reinvested in another title.

Title	Year	Pages	Plates	Print run	Price*	Total sales**
Butterflies	1995	87	16	1000	£12.00	768
Dragonflies	1996	87	16	1000	£12.00	485
Larger Moths	1997	333	16	800	£18.00	313
Hoverflies	1998	244	16	700	£15.00	270
Grasshoppers & Crickets	1999	111	16	700	£12.00	253
Ladybirds	2000	136	16	800	£12.00	337
Amphibians & Reptiles	2001	112	32	800	£13.00	161

*Excluding postage & packing.
**Including trade sales.
[1]Full details obtainable from Surrey Wildlife Trust, School Lane, Pirbright, Woking, Surrey GU24 0JN.

Fig. 2. Production details of the Surrey Wildlife Atlas series to January 2002.

Limitations

In promoting the establishment of a county atlas project, it is also important to bear in mind a number of possible long-term issues, which need to be addressed. Firstly, an atlas is only as good as the level of recording achieved, and good coverage demands considerable effort. Work on the moth and hoverfly volumes started in 1985 and they finally reached the bookshelf in 1997 and 1998 respectively. The Orthoptera volume started earlier still, but stalled with the lack of a suitable publisher. Any prospective recorder should expect to spend around ten years on such a project.

Experience in Surrey and nationally shows that in the period leading up to the production of an atlas there is a definite increase in interest in both recording and submitting records. This rapidly tails off without feedback, and once a project has been completed, interest in further detailed recording wanes quickly. Thus, thought must be given to new projects once the network of recorders is up and running. This is essential if start-stop recording is to be avoided. Secondly, a recording scheme is only as active as the principal co-ordinator, and most co-ordinators are likely to run out of energy; eventually there is a need to think of succession management. Co-ordinators themselves should recognise when their interest has waned and there is a need to find someone with greater enthusiasm to take over a successor scheme.

At the moment, consistent means of recording habitat data are very limited. Not all recorders are necessarily proficient botanists. Furthermore, many do not have access to, say, the National Vegetation Classification (NVC) (e.g. Rodwell, 1992). Equally the NVC may not be the best means of defining invertebrate habitat, which is as much related to structure as it is to species composition. Projects to identify assemblages associated with particular plant communities have a very long way to go, but active and detailed recording should gradually help the process.

Concluding Comments

This account was written following publication of *Hoverflies of Surrey* (Morris, 1998) and after a series of requests for advice on how to prepare and publish an atlas.

It is hoped that it serves that purpose and gives potential recorders some ideas on how to achieve success. The modern county atlas has the potential to appeal to a wider audience than just those students of a chosen subject. This audience may include generalists, ecologists, site managers and consultancies, and of course the statutory nature conservation agencies, so there should be enough for the non-specialist to understand and interpret the importance of particular species or assemblages of species. It is important to bear in mind that the production of atlases is expensive and storage of unsold books is also costly in terms of storage space. Thus it is important to make an atlas or series of atlases sufficiently versatile to the needs of a wider audience and therefore more marketable.

Try to ensure that the data collected are forwarded to the local record centre and national scheme at the earliest possible occasion. These schemes should be seen as the long-term repository for relevant data and may be able to use the data in many other ways. Equally, national schemes may hold data which have not been submitted to the local scheme and should be in a position to download it to you (but be patient).

There is a major chance for the entomological community to provide the sort of feedback which ensures that opposition to collecting does not result in blanket bans and the restriction of entomology to academia and professionals. After all, the majority of our most respected entomological surveyors largely honed their skills in an amateur capacity, and the bulk of the material in museums comes from private collections. At the start of the 21st century, there is scope for a further quantum leap in biological recording providing the foundation for a continuing tradition of amateur natural history recording, which must be the envy of the world.

Forthcoming Volumes on the Fauna of Surrey

The Surrey Wildlife Atlas Project will continue to publish new titles. Projects in hand at the moment include Shieldbugs; Bees, Ants and Wasps; and Mammals. There is an embryonic scheme for British Soldierflies and their allies (together with the Conopidae), and also interest in developing a county checklist for beetles.

Acknowledgements

It seems a very long while since Martin Newman (then Director of Surrey Wildlife Trust), Graham Collins and I sat in a pub in Pirbright musing over a fine pint and the idea of an atlas series. Following that meeting, Martin developed a business plan which he placed before Surrey Wildlife Trust's Council. It was a brave Council decision to support the project and one that has given Surrey Wildlife Trust a high profile as a leader in publishing quality county atlases. Today, the Surrey Wildlife Atlas project has received widespread acclaim, with all volumes receiving excellent reviews. With seven volumes on the shelf and at least three more planned, it makes a huge contribution to our knowledge of the fauna of Surrey. Everyone involved in the project owes much to Martin Newman's enthusiasm for the project and his belief in its financial viability.

The Surrey Wildlife Atlas Project has also been a success because of the combined efforts of individual naturalists who have contributed records and enthusiastic County Recorders. However, equal credit goes to Clare Windsor the designer of the series, to Paul Wickham the present Director of the Surrey Wildlife Trust who has been a strong supporter of the Project, and to Roger Hawkins who has proof-read each volume. It is an example of good practice, which offers a model for others.

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References

Agassiz, D., 1998. Book Review: Larger Moths of Surrey by Graham A. Collins. *Entomologists Record and Journal of Variation* **110**: 147–148.

Baldock, D. W., 1999. *Grasshoppers and Crickets of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

Ball, S. G., Morris, R. K. A., 1992. Progress report 1, March 1992. Hoverfly Newsletter 14.

Burton, R. M., 1983. *Flora of the London Area*. London Natural History Society, London.

Chandler, P. J., 1969. The hover-flies of Kent. *Transactions of the Kent Field Club* **3**: 139–202

Collins, G. A., 1995. *Butterflies of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

Collins, G. A., 1997. *Larger Moths of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

DoE, 1994. *Biodiversity, the UK Action Plan*. HMSO, London.

DoE, 1995. *Biodiversity: the UK Steering Group Report*. HMSO, London.

Emmet, A. M., Pyman, G. A., 1985. The larger moths and butterflies of Essex. *Essex Naturalist* **8**.

Evans, L. K., Evans, K. G. W., 1973. A survey of the macrolepidoptera of Croydon and north-east Surrey. *Proceedings of Croydon Natural History and Scientific Society* **XIV**: 273–408.

Falk, S. J., 1991. *A review of the scarce and threatened bees, wasps and ants of Great Britain*. Research and Survey in Nature Conservation 35. Nature Conservancy Council, Peterborough.

Follett, P., 1996. *Dragonflies of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

Hawkins, R. D., 2000. *Ladybirds of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

Hyman, P., Parsons, M. S., 1992. *A review of the scarce and threatened Coleoptera of Great Britain*. UK Nature Conservation 3. JNCC, Peterborough.

Kirby, P., 1992. *A review of the scarce and threatened Hemiptera of Great Britain*. UK Nature Conservation 2. JNCC, Peterborough.

Lousley, J. E., 1976. *Flora of Surrey*. David and Charles, London.

Marren, P., 2002. Book Reviews: Amphibians & Reptiles of Surrey. *British Wildlife* **13**: 225.

Miles, S., 1999. BENHS Indoor meeting 15 June 1999. *British Journal of Entomology and Natural History* **12**: 247.

Morris R. K. A., 1992. *Hylaeus cornutus* in south London. *British Journal of Entomology and Natural History* **5**: 186–187.

Morris, R. K. A., 1998. *Hoverflies of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.

Morris, R. K. A., 2000. Shifts in the phenology and distribution of hoverflies in Surrey: do these reflect the effects of global warming? *Dipterists Digest* (second series). **7**: 103–108.

Morton, A. J., Collins, G. A., 1992. Distribution analysis of Surrey Lepidoptera using the DMAP computer package. *Nota Lepidopterologica* **15**: 84–88

Philp, E. G., 1982. *Atlas of the Kent Flora*. The Kent Field Club.

Rich, T., 1998. Squaring the circles—bias in distribution maps. *British Wildlife* **9**: 213–219.

Rodwell, J. S., 1995. *British Plant Communities Volume 3. Grassland and montane communities*. Cambridge University Press.

Rotheray, G. E., 1979. *Atlas of the Diptera of Staffordshire part 1: Hoverflies*. Staffordshire Biological Recording Scheme publication No. 5, City Museum & Art Gallery, Stoke on Trent.

Stubbs, A. E., 1982. Hoverflies as primary woodland indicators with reference to Wharncliffe Wood. *Sorby Record* **20**: 62–67.

Whiteley, D., 1987. Hoverflies of the Sheffield area and North Derbyshire. *Sorby Record Special Series* No. **6**

Wycherley, J., Anstis, R., 2001. *Amphibians and Reptiles of Surrey*. Surrey Wildlife Trust, Pirbright, Surrey.